Stress Corrosion Cracking in CO_2 Pipeline with Water Dropout due to Upset

CO_2 Transport and Storage MYRP (1025033)

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FECM/NETL Carbon Management Research Project Review

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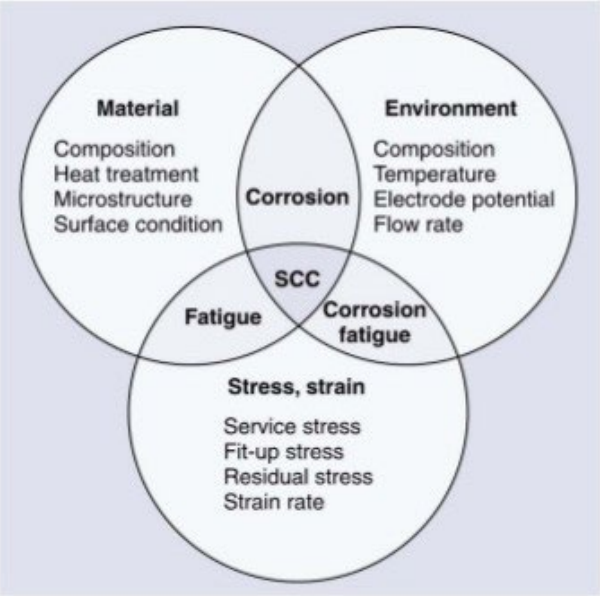
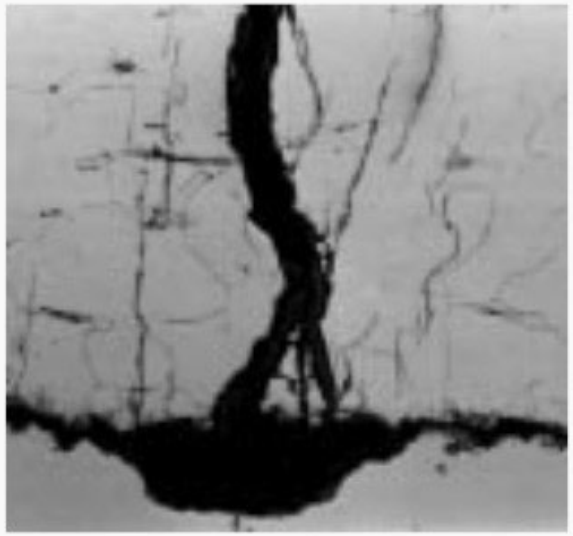
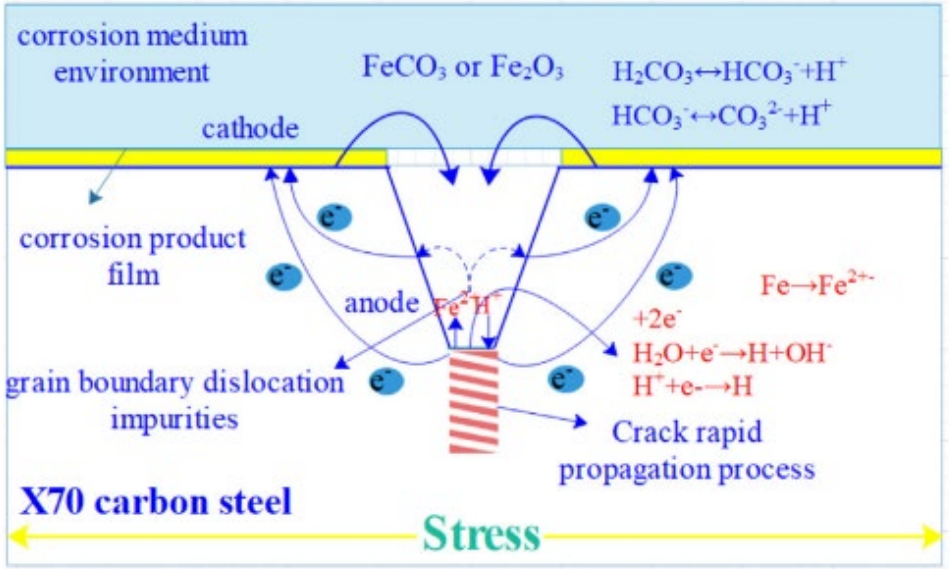
Stress Corrosion Cracking of Carbon Steel in Dense Phase CO_2





Sources: https://www.corrosionpedia.com

Impurities such as H_2S, trace amounts of CO in the presence of oxygen (O_2) and water can cause stress corrosion cracking (SCC) in carbon steel pipelines.

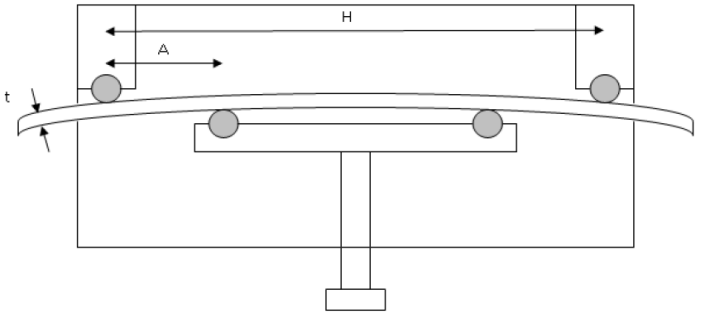


The SCC phenomenon has four key stages:
1.The initiation of stress corrosion cracks
2.The slow growth of cracks
3.The coalescence of cracks
4.Crack propagation and structural failure

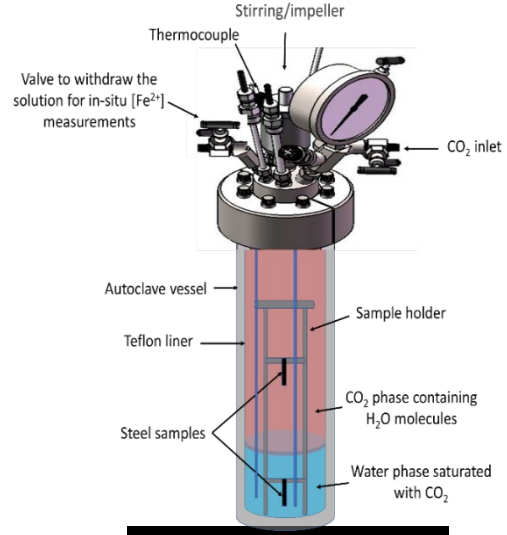
Wang et al., Energy Reports 9 (2023) 266–276

Stress Corrosion Cracking (SCC) of carbon steels under $CO_2/CO/H_2O$ environments

- The SCC work will focus on understanding the SCC initiation mechanisms in base steels and welds.
- NETL will determine SCC based on the stress corrosion test of four-point bend specimens in the technically pure CO_2 and wet CO_2 with and without impurities, followed by SEM observations.
- A standard test method (NACE TM0316) will be followed for the SCC study.
- The pressure, temperature, and impurity content inside the autoclave will be maintained at a specified level to simulate conditions under either $CO_2/CO/H_2O$ environments in process piping before water treatment or CO_2 pipeline with water dropout due to upset.
- The SCC susceptibility will be studied as a function of load, which will vary in the range of 50% -90 % yield strength.
- In these tests, the four-point bend specimens will be placed in water saturated with CO_2 and dense phase CO_2 saturated with water.



Stress corrosion test specimen schematic illustration of typical Four-Point Bend Loading Jig



Autoclave

Collaborators

ExxonMobil

- share results and learnings from EMTEC program on electrochemical and four-point bend testing on the effect of CO, O_2, and applied stress on SCC susceptibility of carbon steels and welds with NETL
- perform advanced characterization and microanalysis of selected samples
- donate carbon steel materials for four-point bend SCC testing at NETL
- Initiate complementary SCC testing in dense phase CO_2 at 3rd party labs which are of mutual interests to EMTEC and NETL

DNV

- perform crack growth rate-based testing to evaluate the effect of various loading parameters as well as the role of changing environmental conditions on the crack growth rate behavior

Project Timeline

Stress Corrosion Cracking (SCC) of carbon steels under CO_2/CO/H_2O environments in process piping before water treatment or CO_2 pipeline with water dropout due to upset

Tasks	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
Literature review	■											
Establish test methodologies and obtain steel samples	■											
Testing SCC behavior of steels under CO2/CO/H2O environments		■	■	■	■	■	■	■	■			
Development and validation of a predictive model for SSC of pipeline steels				■	■	■	■	■	■	■	■	■
Project kick-off and progress meetings	■		■		■		■		■			■

Project Kick-off: June 14, 2024

Any Questions?

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